

CLAIMS

1. (Currently amended) A phosphorus-, perfluoropolyether-, and perfluoroalkyl-containing compound comprising either (i) mono- or poly-alkylene oxide linking groups between the phosphorus and the fluorocarbon group, or (ii) no linking group between the phosphorus and fluorocarbon group, or (iii) individual mixtures of (i) and (ii); said compound does not contain an aryl or arylene group; and said fluorocarbon group is said perfluoropolyether or perfluoroalkyl group.

2. (Original) A compound according to claim 1 comprising a mono- or poly-alkylene oxide linking groups between the phosphorus and the fluorocarbon group.

3. (Currently amended) A compound according to claim 2 wherein
said compound is ~~Formula IA disclosed in the specification~~ has the formula of
 $[Rf-Y]_{(3-y)}P(E)_b[-Y-Rf^1]_y$;

Rf is a polyether chain having a formula weight ranging from 400 to 15,000 and composed of repeating units selected from the group consisting of:

(a) $J-O-(CF(CF_3)CF_2O)_c(CFXO)_dCFZ$, (b) $J^1-O-(CF_2CF_2O)_e(CF_2O)_fCFZ^1$,
(c) $J^2-O-(CF(CF_3)CF_2O)_iCF(CF_3)$, (d) $J^3-O-(CO_2-CF_2CF_2-O)_k-CO_2-CF_2-$,
(e) $J^4-O-(CF_2CF_2O)_lCF_2-$, (f) $J^3-O-(CF(CF_3)CF_2O)_g(CF_2CF_2O)_h(CFX-O)_i-CFZ-$, and
(g) mixtures of two or more thereof and the units with formulae CF_2CF_2O and CF_2O
are randomly distributed along the chain;

J is a fluoroalkyl group selected from the group consisting of CF_3 , C_2F_5 , C_3F_7 , CF_2Cl , C_2F_4Cl , C_3F_6Cl , or mixtures of two or more thereof;

J^1 is a fluoroalkyl group selected from the group consisting of CF_3 , C_2F_5 , CF_2Cl , and C_2F_4Cl ;

J^2 is C_2F_5 or C_3F_7 ;

J^3 is selected from the group consisting of CF_3 , C_2F_5 , and C_3F_7 ;

J^4 is CF_3 or C_2F_5 ;

c and d are numbers such that the c/d ratio ranges from 0.01 to 0.5, and the formula weight ranges from 400 to 15,000;

e and f are numbers such that the e/f ratio ranges from 0.3 to 5, and the formula weight is from 400 to 15000;

g, h and i are numbers such that (g + h) ranges from 1 to 50, the i/(g + h) ratio ranges from 0.1 to 0.05, and the formula weight is from 400 to 15,000;

k is a number such that the formula weight ranges from 400 to 15,000;

l is a number such that the formula weight ranges from 400 to 15,000;

each Q is independently F, Cl, or H;

b is zero or 1;

E is oxygen or sulfur;

Rf^l is Q-(C_mF_{2m})- representing a monovalent branched or straight chain

polyfluoroalkyl group;

m has a value from 1 to 20;

X is -F, -CF₃, or mixtures thereof;

y is 0.05 to 2;

Y is (CH₂)_zO(CH₂CH₂O)_{z^l};

z is 1 to 4;

z^l is 0, 1 or 2;

Z is -F, -Cl or -CF₃;

Z^l is -F or -Cl.

4. (Currently amended) A compound according to claim 2 wherein said compound is ~~Formula IB disclosed in the specification~~ has the formula of [Rf-Y]_{(3-y)P(E)_b[-OCH(Rf^l)₂]_y; and Rf, Y, y, E, b, and Rf^l are as recited in claim 3.}

5. (Currently amended) A compound according to claim 2 wherein said compound is ~~Formula IIA disclosed in the specification~~ has the formula of [Rf^l-Y-]₂P(E)_b[-Y-Rf²-Y-]P(E)_b[-Y-Rf^l]₂;

Rf^l, Y, E, and b are as recited in claim 3;

Rf² is a divalent perfluoropolyether chain segment that can have a number average formula weight of 500 to 15,000 and can be selected from the group consisting of (i) (CF₂CF₂O)_e(CF₂O)_fCF₂-, (ii) (C₃F₆O)_p(CF₂CF₂O)_q(CFXO)_rCF₂-, (iii) (CF₂CF₂O)_k(C₃F₆O)_lCF(CF₃)-, (iv) CF(CF₃)O(C₃F₆O)_w-Rf³-O-(C₃F₆O)_wCF(CF₃)-, (v) ((CO₂)CF₂CF₂O)_sCF₂CF₂-, and mixtures of two or more thereof and the units with formulae CF₂CF₂O and CF₂O are randomly distributed along the chain;

Rf³ is linear or branched C_aF_{2a};

a is 3 to 30;

e, f, k, and l are the same as recited in claim 3;

p, q and r are numbers such that (p+q) ranges from 1 to 50, and the r/(p+q) ratio ranges from 0.1 to 0.05, and the formula weight is from 400 to 15,000;

s is a number such that the formula weight ranges from 400 to 15,000; and

w is independently 2 to 20.

6. (Currently amended) A compound according to claim 2 wherein said compound is ~~Formula IIB disclosed in the specification~~ has the formula of $[(Rf^1)_2CHO-]_2P(E)_b[-Y-Rf^2-Y-]P(E)_b[-OCH(Rf^1)_2]_2$; and Rf^1 , E, b, Y, and Rf^2 are as recited in claim 5.

7. (Original) A compound according to claim 1 comprising no linking group between the phosphorus and fluorocarbon group.

8. (Currently amended) A compound according to claim 7 wherein said compound is ~~Formula III disclosed in the specification~~ has the formula of $[(Rf)]_{(3-y)}-P(E)_b[Rf^1]_y$; and Rf , y, E, b, and Rf^1 are the same as recited in claim 3.

9. (Currently amended) A compound according to claim 7 wherein said compound is ~~Formula IV disclosed in the specification~~ has the formula of $[Rf^1]_2-P(E)_bRf^2-P(E)_b[Rf^1]_2$; and Rf^1 , E, b, and Rf^2 , are as recited in claim 5.

10. (Original) A compound according to claim 1 comprising only one mono-alkylene oxide or polyalkylene oxide linking group and having the proviso of (1) when said perfluoroether has a mono- or poly-alkylene oxide linking group, said fluoroalkyl has no linking group and (2) when said fluoroalkyl has a mono- or poly-alkylene oxide linking group, said perfluoroether has no linking group.

11. (Currently amended) A compound according to claim 10 wherein said compound is ~~Formula V disclosed in the specification~~ has the formula of $[Rf-Y-]_{(3-y)}P(E)_b[Rf^1]_y$; and Rf , Y, y, E, b, and Rf^1 are the same as recited in claim 3.

~~13~~12. (Currently amended) A compound according to claim 10 wherein said compound is ~~Formula VIA disclosed in the specification~~ has the formula of $[Rf-]_{(3-y)}P(E)_b[-Y-Rf^1]_y$; and Rf , y, E, b, Y, and Rf^1 are the same as recited in claim 5.

~~14~~13. (Currently amended) A compound according to claim 10 wherein said compound is ~~Formula VIB disclosed in the specification~~ has the formula of $[Rf-Y-]_{(3-y)}P(E)_b[-OCH(Rf^1)_2]_y$; and Rf , Y, y, E, b, and Rf^1 are the same as recited in claim 3.

~~15~~14. (Currently amended) A compound according to claim 10 wherein said compound is ~~Formula VII disclosed in the specification~~ has the formula of $[Rf^1-]_2P(E)_b[-Y-Rf^2-Y-]P(E)_b[Rf^1]_2$; and Rf^1 , E, b, Y, and Rf^2 are the same as recited in claim 5.

~~16~~15. (Currently amended) A compound according to claim 10 wherein said compound is ~~Formula VIIIA disclosed in the specification~~ has the formula of $[Rf^1-Y-]_2P(E)_b[Rf^2]P(E)_b[-Y-Rf^1]_2$; and Rf^1 , Y, E, b, and Rf^2 are the same as recited in claim 5.

~~17~~16. (Currently amended) A compound according to claim 10 wherein said compound is ~~Formula VIIIB disclosed in the specification~~ has the formula of $[(Rf^1)_2-CHO]_2P_2(E)_b[Rf^2]P(E)_b[-OCH(Rf^1)_2]_2$; and Rf^1 , E, b, and Rf^2 are the same as recited in claim 5.

~~18~~17. (Original) A compound according to claim 1 wherein said compound is a partially esterified phosphate, a partially esterified phosphonate, a salt of a partially esterified phosphate, a salt of a partially esterified phosphonate, or mixtures of two or more thereof.

~~19~~18. (Original) A compound according to claim ~~18~~17 comprising a mono- or poly-alkylene oxide linking groups between the phosphorus and the fluorocarbon group.

~~20~~19. (Currently amended) A compound according to claim ~~19~~18 wherein said compound is ~~Formula IXA disclosed in the specification~~ has the formula of $[Rf-Y-]_{(3-x-y)}P(E)-[-Y-Rf^1]_y[OM]_x$; Rf , Y, y, E, and Rf^1 are the same as recited in claim 3; x is 0.05 to 1; and M is hydrogen, alkali metal, alkaline earth metal, or ammonium.

~~21~~20. (Currently amended) A compound according to claim ~~19~~18 wherein said compound is ~~Formula IXB disclosed in the specification~~ has the formula of $[Rf-Y-]_{(3-x-y)}P(E)-[-OCH(Rf^1)_2]_y[OM]_x$; and Rf , Y, x, y, E, Rf^1 , and M are the same as recited in claim 19.

~~22~~21. (Currently amended) A compound according to claim ~~19~~18 wherein said compound is ~~Formula XA disclosed in the specification~~ has the formula of $[MO]_x[Rf^1-Y-]_{(2-x)}P(E)-[Y-Rf^2-Y-]P(E)-[Y-Rf^1]_{(2-x)}[OM]_x$; M, x, Rf^1 , E, and Y are the same as recited in claim 19; and Rf^2 is the same as recited in claim 5.

2322. (Currently amended) A compound according to claim ~~19~~**18** wherein said compound is ~~Formula XB disclosed in the specification~~ has the formula of $[MO]_x[(Rf^1)_2-CHO]_{(2-x)}-P(E)[-Y-Rf^2-Y]_yP(E)[-OCH-(Rf^1)_x]_{(2-x)}[OM]_x$; and M, x, Rf^1 , E, Y, and Rf^2 are the same as recited in claim 21.

2423. (Currently amended) A compound according to claim ~~18~~**17** comprising no linking group between the phosphorus and fluorocarbon group.

2524. (Currently amended) A compound according to claim ~~18~~**23** wherein said compound is ~~Formula XI disclosed in the specification~~ has the formula of $[Rf-]_{(3-x-y)}-P(E)[-Rf^1]_y[OM]_x$; and Rf, x, y, E, Rf^1 , and M are the same as recited in claim 19.

2625. (Currently amended) A compound according to claim ~~18~~**23** wherein said compound is ~~Formula XII disclosed in the specification~~ has the formula of $[MO]_x[Rf^1-]_{(2-x)}-P(E)Rf^2-P(E)[-Rf^1]_{(2-x)}[OM]_x$; and M, Rf^1 , x, E, M, and Rf^2 are the same as recited in claim 21.

2726. (Currently amended) A compound according to claim ~~18~~**17** comprising only one mono-alkylene oxide or polyalkylene oxide linking group and having the proviso of (1) when said perfluoroether has a mono- or poly-alkylene oxide linking group, said fluoroalkyl has no linking group and (2) when said fluoroalkyl has a mono- or poly-alkylene oxide linking group, said perfluoroether has no linking group.

2827. (Currently amended) A compound according to claim ~~27~~**26** wherein said compound is ~~Formula XIII disclosed in the specification~~ has the formula of $[Rf-Y]_{(3-x-y)}P(E)[-Rf^1]_y[OM]_x$; and Rf, Y, Rf^1 , x, y, E, and M are the same as recited in claim 19.

2928. (Currently amended) A compound according to claim ~~27~~**26** wherein said compound is ~~Formula XIVA disclosed in the specification~~ has the formula of $[Rf-]_{(3-x-y)}P(E)[-Y-Rf^1]_y[OM]_x$; and Rf, x, y, E, Y, Rf^1 , and M are the same as recited in claim 19.

3029. (Currently amended) A compound according to claim ~~27~~**26** wherein said compound is ~~Formula XIVB disclosed in the specification~~ has the formula of $[Rf-]_{(3-x-y)}P(E)[-OCH-(Rf^1)_2]_y[OM]_x$; and Rf, Rf^1 , x, y, E, and M are the same as recited in claim 19.

3130. (Currently amended) A compound according to claim 2726 wherein said compound is ~~Formula XV disclosed in the specification~~ has the formula of $[MO]_x[Rf^1-]_{(2-x)}P(E)[-Y-Rf^2-Y-]P(E)[-Rf^1]_{(2-x)}[OM]_x$; and M, Rf^1 , x, E, Y, and Rf^2 are the same as recited in claim 21.

3231. (Currently amended) A compound according to claim 2726 wherein said compound is ~~Formula XVII disclosed in the specification~~ has the formula of $[MO]_x[Rf^1-Y-]_{(2-x)}P(E)[-Rf^2-]P(E)[-Y-Rf^1]_{(2-x)}[OM]_x$; and M, Rf^1 , x, E, Y, and Rf^2 are the same as recited in claim 21.

3332. (Currently amended) A compound according to claim 2726 wherein said compound is ~~Formula XVII disclosed in the specification~~ has the formula of $[MO]_x[Rf^1-CHO-]_{(2-x)}P(E)[-Rf^2-]P(E)[-OCH-(Rf^1)_2]_{(2-x)}[OM]_x$; and M, Rf^1 , x, E, Y, and Rf^2 are the same as recited in claim 21.

3433. (Currently amended) A composition comprising a phosphorus-, perfluoropolyether-, and perfluoroalkyl-containing compound and optionally a thickener wherein said compound is the same as that disclosed in claim 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, or 32 ~~one of Formulae IA to XVII disclosed in the specification~~.

~~[[35]]~~**34.** (Currently amended) A composition according to claim ~~[[34]]~~**33** wherein said compound is a partially esterified phosphate, a salt of a partially esterified phosphate, or mixtures thereof.

~~[[36]]~~**35.** (Currently amended) A composition according to claim ~~[[34]]~~**33** wherein said compound is a partially esterified phosphonate, a salt of a partially esterified phosphonate, or mixtures thereof.

~~[[37]]~~**36.** (Currently amended) A composition according to claim ~~[[34]]~~**33** where said thickener is polytetrafluoroethylene.

~~[[38]]~~**37.** (Currently amended) A composition according to claim ~~[[35]]~~**34** where said thickener is polytetrafluoroethylene.

~~[[39]]~~**38.** A composition according to claim ~~[[36]]~~**35** where said thickener is polytetrafluoroethylene.

4039. (Currently amended) A recording medium comprising a lubricant, which comprises a phosphorus-, perfluoropolyether-, and perfluoroalkyl-containing

compound ~~recited in one of claims 1 to 39~~ as recited in claim 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, or 32.

40. (New) A recording medium comprising a lubricant, which comprises a phosphorus-, perfluoropolyether-, and perfluoroalkyl-containing compound as recited in claim 33.

41. (New) A recording medium comprising a lubricant, which comprises a phosphorus-, perfluoropolyether-, and perfluoroalkyl-containing compound as recited in claim 34.

42. (New) A recording medium comprising a lubricant, which comprises a phosphorus-, perfluoropolyether-, and perfluoroalkyl-containing compound as recited in claim 35.

43. (New) A recording medium comprising a lubricant, which comprises a phosphorus-, perfluoropolyether-, and perfluoroalkyl-containing compound as recited in claim 36.

44. (New) A recording medium comprising a lubricant, which comprises a phosphorus-, perfluoropolyether-, and perfluoroalkyl-containing compound as recited in claim 37.

45. (New) A recording medium comprising a lubricant, which comprises a phosphorus-, perfluoropolyether-, and perfluoroalkyl-containing compound as recited in claim 38.